November 12, 1964

John C. and Bill M.

STAT Enclosed is [redacted] proposal for a Binocular Tube Magnifier in response to your Development Objectives dated 14 April 1964. Separate copies are being sent to Paul L. and Bob N.

The use of a flat mirror as shown in Fig. 2 is probably required to keep production cost down. It might be worthwhile in a follow-on program to try to substitute an off-axis condenser mirror for the on-axis condenser mirror, flat mirror combination. Theoretically this would double the brightness. Unless some simple manufacturing technique could be discovered, the off-axis condenser mirror would probably quadruple the production item cost. I think it would be more advisable to consider only the proposed design for a first article and reserve the possibility of improvement for later consideration.

It is not clear to me why the 10X and 20X would have the same field of view.

[redacted] STAT

Enc.

Declass Review by NGA.

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CATADIOPTRIC BINOCULAR TUBE MAGNIFIER

105-64

November 1964

One copy in file

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CATADIOPTRIC BINOCULAR TUBE MAGNIFIER

General:

This report briefly discusses a completely new approach toward achieving a compact, very wide field optics for low magnification viewing. Unlike conventional magnifiers, which for wide fields demand complex (and therefore expensive and heavy) wide field eyepieces, the [ ] proprietary design utilizes an immersed reflector field lens specifically introduced to relieve the unusual requirements on the eyepiece. The result, as shown in Figure 1, is an extraordinarily compact, high quality magnifier. The "opera glasses" configuration readily lends itself to ruggedization and is ideally suited for around-the-neck lanyard retention and use. A knurled ring and diopter scale at each eyepiece provides independent focus control. Interpupilary distance adjustment is selected, as with binocular telescopes, by relative tilt control of the eyepiece wings. Both the 10X and the 20X versions of the magnifier will, as indicated by preliminary design studies, have identical field lenses and eyepieces. This feature will permit a binocular magnifier to be "converted" to another power simply by changing its objective and its standoff pieces.

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The basic configuration, the dimensional relations and the field coverage for the binocular magnifier as shown in Figure 1 have been verified by preliminary analyses. The specific design of the objective (or objectives) and of the eyepieces, for 10X and 20X magnification, and the resultant determination of the image quality throughout the field, are beyond the scope of the company funded program. Therefore, it is proposed that development effort be split into two phases:

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Phase I. Design:

During this phase the optical system for both 10X and 20X Catadioptric Binocular Magnifiers will be designed and verified by computer ray tracing. Concurrently, a complete mechanical design layout will be made, indicating in detail the shape, size, adjustment means and arrangement and mounting of optical components. At the conclusion of this phase, a report will be submitted to the contracting agency describing the designed magnifiers together with their optical performances. Where tradeoffs are indicated, these will be presented in detail. With this report, a fixed price and schedule will be submitted for the fabrication of one each of the 10X and 20X magnifiers.

Phase II. Fabrication:

Contingent upon the contracting agency's acceptance of the designs, as submitted in Phase I and as modified by design reviews, the fabrication phase will consist of construction, laboratory verification and delivery of two prototype Catadioptric Binocular Magnifiers, one 10X and one 20X.

The following section presents the Te catadioptric configuration proposed for the magnifier and discusses the requirements for this magnifier.

Catadioptric Binocular Magnifier:

The optical schematic for the catadioptric magnifier is shown in Figure 2. The common objective is essentially at the entrance pupil of the system. Aft of the objective, light is split laterally by 45° roof prisms (which rock with the eyepiece wings). Subsequent to beam splitting, the light is kept in the glass medium, gaining the advantage

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of field angle reduction by the higher index of refraction of the medium. At the field mirror, light received from the roof is redirected via the 50% reflecting flat mirror to the eyepiece. The net transmission of 25% through the flat mirror can, it is expected by proper design, be compensated by reduction of the numerical aperture of the objective.

Unlike conventional magnifiers, the catadioptric configuration tolerates a relatively low power eyepiece. Correspondingly, since the field lens is nearly 1:1 in magnification effectiveness, the objective is relatively high power. On the basis of the preliminary analysis of this instrument, the performances are:

Magnification: 10X or 20X

Resolution: 6 lpmm per power across field

Image Quality: Comparable to that of high quality microscopes

Field of View: 0.5 inches diameter at object (minimum requirement for either power)

Objective Numerical Aperture: 0.5 maximum

Standoff: 10mm (X20), 20mm (X10)

Entrance Pupil: 10mm diameter

Exit Pupil: 7mm minimum

Eye Relief: 4-5 mm

In the design phase of the proposed program, the resolution and image quality requirements are to be the design goals for the catadioptric system. If these can be exceeded, tradeoffs, extending the field of view and expanding the exit pupil and eye relief will be established.

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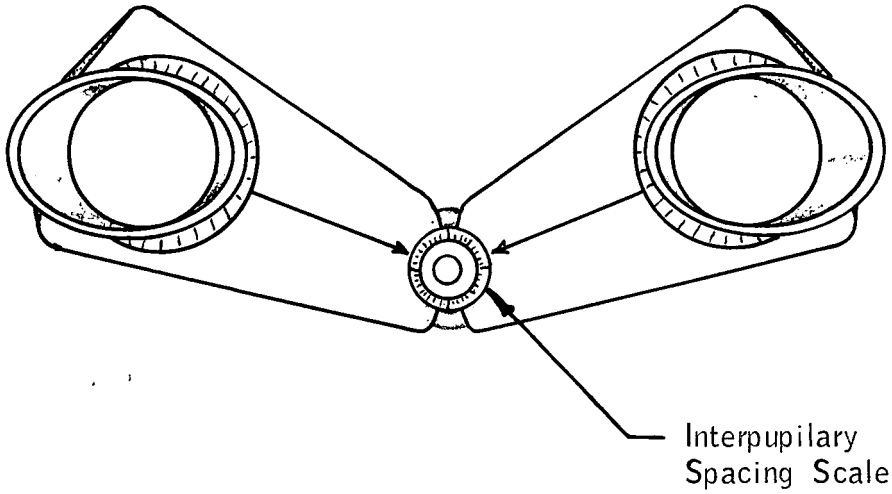

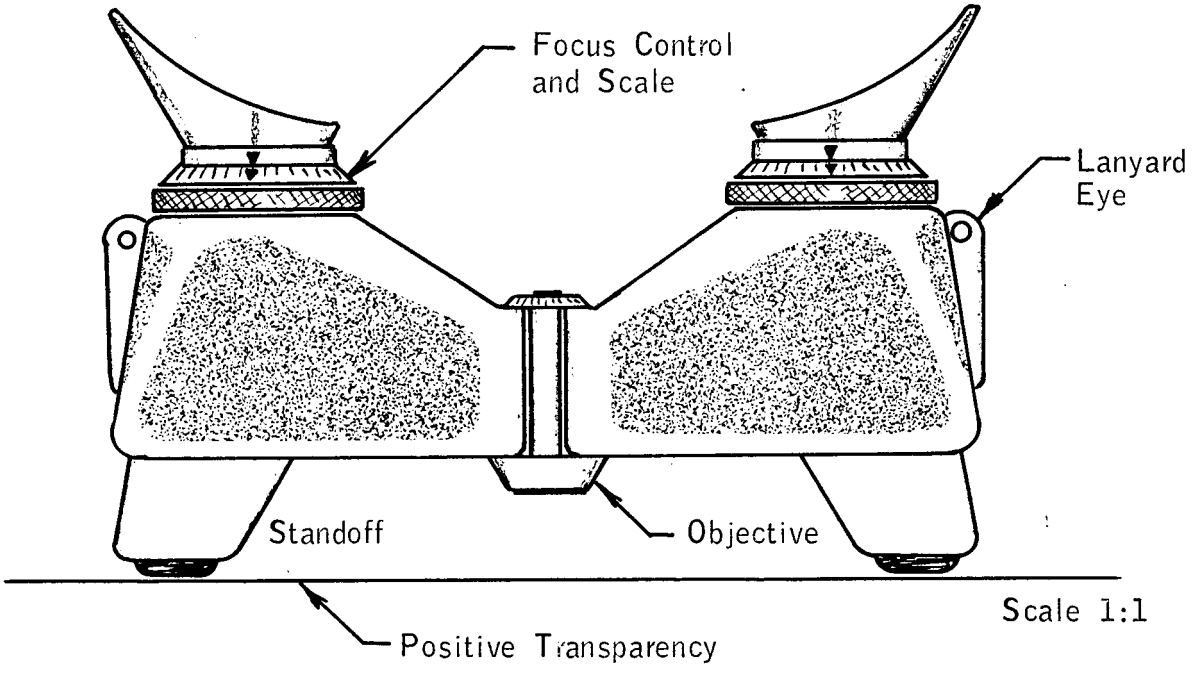

Figure 1

CATADIOPTRIC BINOCULAR MAGNIFIER

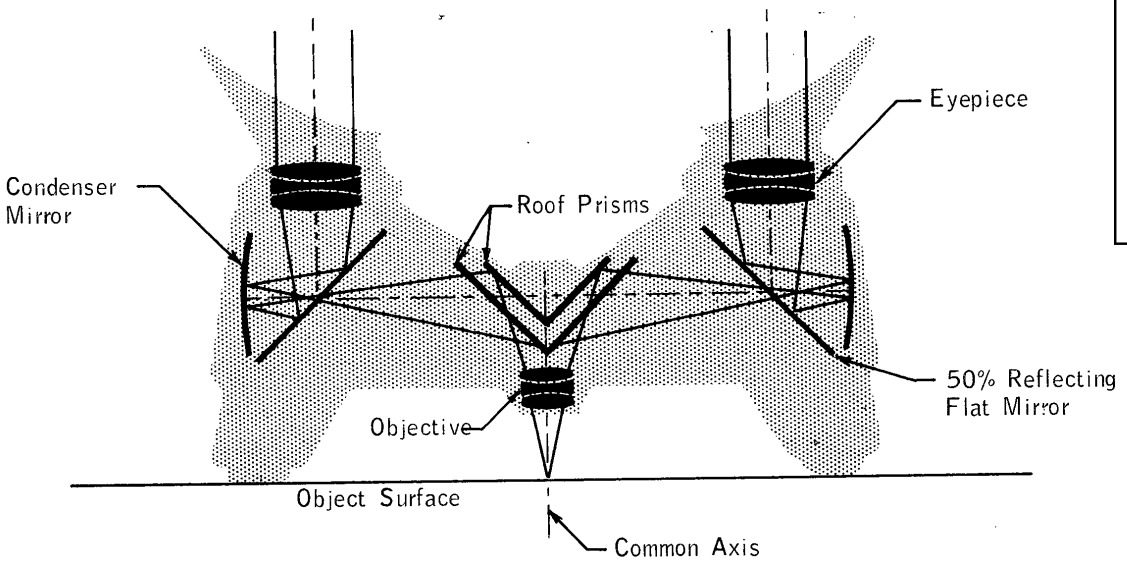

Figure 2

OPTICAL SCHEMATIC - CATADIOPTRIC BINOCULAR MAGNIFIER